**An Introduction to Punnett Squares**

Punnett squares are diagrams used to help us predict the characteristics of the offspring that may result from two parents:

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |



Each Punnett square examines only **one** trait, for example, Gregor Mendel examined the colour of pea pods.

He crossed a homozygous green pod (GG) with a homozygous yellow pod (gg).

Mendel had to wait until offspring were produced from this cross to see the results, however, using a Punnett square, we can determine the likely combination of offspring.

**Step 1: Place the genotype of parent 1 across the top of the Punnett square:**

|  |  |  |
| --- | --- | --- |
|  | G | G |
|  |  |  |
|  |  |  |

*Genotype of parent 1*

**Step 2: Place the genotype of parent 2 down the left hand side of the Punnett square:**

|  |  |  |
| --- | --- | --- |
|  | G | G |
| g |  |  |
| g |  |  |

*Genotype of parent 2*

**Question 1:** What does each letter represent? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Each box left in the Punnett square will represent a possible offspring, each inheriting one allele from each parent.

**Step 3: Fill in the genotypes of the offspring:**

**Question 2:** Can you guess how to fill the Punnett square in? It has been started for you.

|  |  |  |
| --- | --- | --- |
|  | G | G |
| g | Gg |  |
| g |  |  |

**Question 3:** Describe the genotype and phenotype of the offspring created from Mendel’s cross

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 4:** These offspring (called the F1 generation) were then crossed to each other. Fill in the following Punnett square to show the expected genotypes of offspring (called the F2 generation):

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |

**Step 4: State the proportions of offspring with each genotype/phenotype:**

When describing the resulting offspring, you may be asked to express your answer in 3 different ways: as a percentage (e.g. 65%), ratio (e.g. 6:1), or fraction (e.g. 1/3).

**Question 5:** Express the genotypes and phenotypes of the offspring from the second cross in each of these three forms:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Percentages** | **Ratios** | **Fractions** |
| Genotypes | \_\_\_\_\_ GG  \_\_\_\_\_ Gg  \_\_\_\_\_ gg |  |  |
| Phenotypes | \_\_\_\_\_ Green  \_\_\_\_\_ Yellow |  |  |

**What is this information really telling us?**

* *For every 4 offspring produced by the F1 pea plants, 3 will be green and 1 will be yellow*
* *For every 4 offspring produced by the F1 pea plants,1 will be homozygous dominant, 2 will be heterozygous and 1 will be homozygous recessive*
* And many other things….

**Question 6:** Make one other statement similar to the ones above about the offspring from a Gg x Gg cross of pea plants: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

One important point from this cross is the **expected ratio** of 3 green: 1 yellow pea plant. This ratio of 3 offspring showing the dominant phenotype: 1 offspring showing the recessive phenotype can be expected is any cross where both parents are heterozygous.

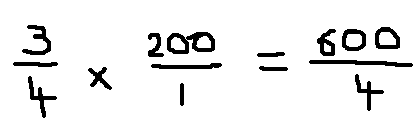
**Question 7:** How many offspring would be expected to show each of the following genotypes and phenotypes for the cross above if 200 offspring were produced? What if 60 offspring were produced?

**200 offspring 60 offspring**

***How do I work this out?***

3/4 of the offspring are expected to be green.

Therefore, I need to find 3/4 of 200:



Green 150 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Yellow \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Homozygous dominant \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Homozygous recessive \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Heterozygous \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Remember that this is only a prediction of the offspring that will result.

Punnett squares can also be useful in determining the chances of a particular trait being passed on to offspring (e.g. a genetic disease).

**Answers**

1. Letters represent the genotype of the parent. Each individual letter represents an allele for a particular trait (in this case pod colour in pea plants – G = allele for green pod, g = allele for yellow pod).

|  |  |  |
| --- | --- | --- |
|  | G | G |
| g | Gg | Gg |
| g | Gg | Gg |

1. All heterozygous (Gg), all green.

|  |  |  |
| --- | --- | --- |
|  | G | g |
| G | GG | Gg |
| g | Gg | gg |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Percentages** | **Ratios** | **Fractions** |
| Genotypes | 25% GG  50% Gg  25% gg | 1 GG: 2 Gg: 1 gg | ¼ GG  ½ Gg  ¼ gg |
| Phenotypes | 75% Green  25% Yellow | 3 Green: 1 Yellow | ¾ Green  ¼ Yellow |

1. Many statements possible.

**200 offspring 60 offspring**

Green 150 45

Yellow 50 15

Homozygous dominant 50 15

Homozygous recessive 100 30

Heterozygous 50 15